The Road Forward **Climate-Conscious** Pavement Design

SUSTAINABILITY AND RESILIENCE

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Sustainability and resilience are concepts that are increasingly at the forefront of the planning, design, construction, and management of transportation infrastructure in general and pavements in particular. The two terms are often used interchangeably, yet they are distinctly different concepts. Nevertheless, various practices in asphalt paving and attributes of asphalt pavement can contribute to both sustainability and resilience goals, as illustrated in the Venn diagram in Figure 1.

The Federal Highway Administration (FHWA) Sustainable Pavements Program describes sustainability in the context of pavements as system characteristics that indicate a pavement's ability to: achieve the engineering goals for which it was constructed; preserve and restore surrounding ecosystems; use financial, human, and environmental resources economically; and meet basic human needs such as health, safety, equity, employment, comfort, and happiness[1]. For asphalt pavements, examples of sustainable practices include using reclaimed asphalt pavement (RAP) and other recycled materials, warm-mix technologies, cleaner energy and fuel sources, and optimizing plant operations to reduce emissions.

WHAT'S THE DISTINCTION?

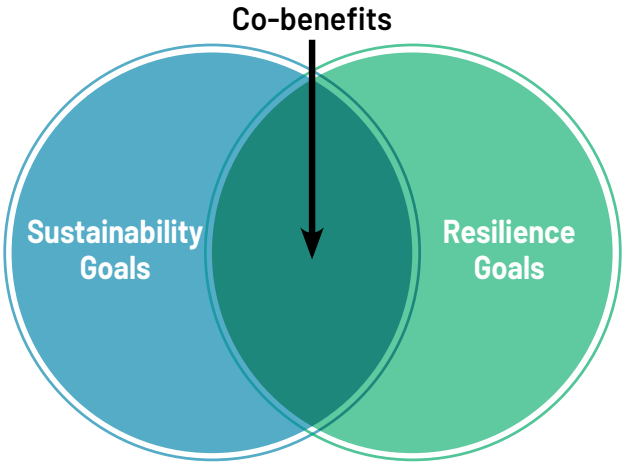

Figure 1: Distinguishing Sustainability and Resilience

FHWA defines resilience as the ability to anticipate, prepare for, and adapt to changing conditions, as well as to withstand, respond to, and recover rapidly from disruptions. This includes the ability to resist hazards or withstand impacts from weather events and natural disasters, or reduce the magnitude or duration of impacts of a disruptive weather event or natural disaster on a project; and to have the absorptive capacity, adaptive capacity, and recoverability to decrease project vulnerability to weather events or other natural disasters[2].

[1]https://www.fhwa.dot.gov/pavement/sustainability/start-here/
[2]Statutory Definition of "Resilience" at 23 U.S.C. § 101(a)(24). Section 11103 of the Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act, Pub. L. 117-58 (Nov. 15, 2021)

For asphalt pavements, examples of resilient practices include using a different binder grade to accommodate hotter or colder temperatures, a perpetual pavement design to provide extra structural capacity during flood events, porous pavements to store and treat stormwater, and less moisture-sensitive materials in flood-prone areas.

As seen from the above definitions, the focus of sustainability is to essentially 'do the right thing' for future generations and the planet while resilience focuses on response to outside stressors such as climate.

HOW SUSTAINABILITY AND RESILIENCE OVERLAP

While sustainability and resilience are generally discussed and evaluated separately, in many circumstances they can and should overlap as they relate to asphalt pavements. Practices that are initiated to meet sustainability goals should also be viewed through the lens of resilience to identify and recognize any co-benefits and vice versa. In fact, resilience can be incorporated directly as one or more clearly defined engineering goals.

Take, for example, a pavement that is vulnerable to flooding. An engineering goal for the design of this pavement would be to make it resilient to flooding. Using base materials that are stiffer or less susceptible to changes in moisture content than a traditional unbound granular base would achieve this goal from a resilience perspective.

Various choices will have different potential impacts from a sustainability perspective and should be evaluated through a sustainability assessment (e.g., LCA and LCCA) to determine the optimum choice in terms of environmental and economic impacts. For example, the use of either cold recycled asphalt (CIR, CCPR, or FDR) or stabilized (lime or cement) aggregate in the base layer will make the pavement more resilient to flooding. However, the choice of the recycled asphalt material will provide sustainability co-benefits that the stabilized material does not offer.

THE TAKEAWAY

Both sustainability and resilience need to be considered in the planning, design, construction, and management of asphalt pavements. While these concepts are distinct and evaluated separately, there are many opportunities for engineers,designers, and producers to leverage practices that provide benefits from both perspectives. These co-benefits should be clearly expressed to highlight the value of asphalt pavements in the transportation network of the future.

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